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NON-INVASIVE MEDICAL TREATMENT INSTALLATION

The invention concerns a system for non-invasive medical treatment in which a therapy apparatus (perhaps a shockwave head in the case of a lithotripsy treatment) is directed on an orbit around a patient table or, respectively, around a patient borne on this patient table. A body region of the patient to be treated is thereby arranged in the isocenter of the cited orbit. The focus of the therapy apparatus (in the case of a shockwave head thus the focus of the ultrasonic waves emanating from it) is thereby located in the isocenter or, respectively, in the body region to be treated. A circular arc, what is known as a C-arm, is generally used for guidance of the therapy apparatus. Given a C-arm permanently fixed at the base frame, this C-arm must exhibit an arc length that is at least as large as the desired movement path of the therapy apparatus. The arc length of the C-arm can be shortened when this is born such that it can be moved orbitally on the base frame. A therapy apparatus movably guided on a C-arm has the advantage that it can be positioned on different sides of the body of a patient without the patient having to be repositioned on the patient table. A system of the addressed type is normally designed such that the base frame and further system parts are arranged on one side of the patient table, whereby the other side of the patient table should remain essentially free in order to enable a hindrance-free access to the patient (perhaps for anesthesia purposes). If a therapy apparatus should now be brought into position on this side of the patient table, the therapy apparatus itself is less disruptive than the C-arm in fact because said therapy apparatus is positioned relatively close to the patient. If, for example, a shockwave head is positioned in the 0° position (i.e. in the upper table position given vertical alignment of its shockwave axis) for lithotripsy treatment, the C-arm extends into the space above the patient at least up to this angle position. A treating doctor is thereby severely limited in terms of his freedom of movement in the region of his head.

Starting from this, it is the object of the invention to propose a system for non-invasive medical treatment with which this disadvantage is circumvented.

This object is achieved according to claim 1. A carrier arm exhibiting a fixed end and a free end is accordingly arranged on the therapy C-arm, whereby the carrier arm with its fixed end is borne on the therapy C-arm between two end position [sic] predetermined by the arc ends such that said carrier arm with its fixed end can move in an orbit, and said carrier arm bears the therapy apparatus on its free end. The carrier arm is furthermore borne on the therapy C-arm such that it can rotate around a rotation axis, whereby it can be aligned at both end positions such that it extends beyond the respective arc end. The rotatable bearing of the carrier arm on the therapy C-arm ensures that such a projection beyond the arc end can also be produced in a simple manner at the respective other end position.

The rotation axis of the carrier arm is advantageously aligned such that it intersects the focus of the therapy apparatus. It is thereby ensured that, given a rotation of approximately 180° around the rotation axis of the therapy focus, its position is not altered. This position typically lies in the isocenter of a C-arm. The position of the therapy focus is thus altered neither by an orbital movement of the carrier arm nor by a rotation around the rotation axis.

In a further preferred embodiment, the therapy apparatus is arranged such that its focus is located in a plane that runs parallel to and removed from the orbital plane of the therapy C-arm. Via this embodiment it is possible to remove the effective location of the therapy apparatus from the orbital plane of the therapy C-arm and thereby to achieve even more freedom of movement in the region of the therapy C-arm for a person attending the patient. However, this embodiment is particularly advantageous when, with regard to an imaging accompanying a treatment, an x-ray C-arm is arranged coaxial, coplanar and with axial offset relative to the therapy C-arm, whereby the focus of the therapy apparatus coincides with the isocenter of the x-ray C-arm. In addition to the increased freedom of movement (already mentioned) for medical personnel, the advantage thereby results that the x-ray C-arm can in practice be moved orbitally without hindrance. Given an arrangement

of x-ray and therapy C-arms in which the orbital planes of both arcs coincide, the orbital movement capability of the x-ray C-arm is significantly limited, for example because x-ray source or x-ray receiver protrude into the movement path of the therapy C-arm.

The invention is now explained in detail using an exemplary embodiment shown in the accompanying drawings. Shown are:

Fig. 1	in perspective representation, a base frame of a system for therapeutic treatment on which is borne a therapy C-arm bearing a therapy apparatus, which therapy C-arm is borne such that it can move orbitally or, respectively, around an isocenter,
Fig. 2	a section from Fig. 1 in perspective representation,
Fig. 3	a section from a system in perspective representation, in which an x-ray C-arm is associated with the therapy C-arm,
Fig. 4	an illustration corresponding to Fig. 1, in which the therapy apparatus is located in a different position,
Fig. 5	a schematic, perspective representation which shows the position of the therapy apparatus from Fig. 4 in an application-related situation,
Fig. 6	a schematic representation of a therapy C-arm and of an associated x-ray C-arm.

A system shown in the illustrations comprises a base frame 1 on which is fixed a first C-arm that bears a therapy apparatus (for example the shockwave head 2 of a lithotripsy system). The first C-arm (designated in the following with therapy C-arm 3) is an annulus segment which can be orbitally moved on an extension arm 4

of the base frame 1 around its middle point or, respectively, around its isocenter 5, which is indicated in Fig. 1 by the double arrow 6. A sled 7 is borne on the therapy C-arm 3 such that it can move orbitally (thus corresponding to double arrow 6). A carrier arm 9 is attached with its fixed end 10 on a side 8 of the sled facing the isocenter 5. The free end 12 of the carrier arm 9 bears the shockwave head 2. Due to the orbital movement capability of the therapy C-arm 3 and of the sled 7, the shockwave head 2 can be positioned in various angle position [sic] relative to the isocenter 5 or, respectively, to a patient table 15. The radial separation of the shockwave head 2 from the isocenter 5 is selected such that the focus 13 of a shockwave cone 14 emitted from the shockwave head 2 lies on a central axis 18 extending through the isocenter 5. The shockwave head 2 can thereby, for example, be arranged such that its shockwave axis 16 runs in the orbital plane 17 spanned by the therapy C-arm 3.

As is recognizable from Fig. 1 and in particular from Fig. 2, the carrier arm 9 is designed or, respectively, aligned such that, in its upper end position (Fig. 2), it extends beyond the upper arc end 19 in the arc circumference direction, viewed in the direction of the central axis 18 situated perpendicular to the orbital plane 17 and extending through the isocenter 5. A hindrance-free accessible space 20 in the head region of a person attending a patient during the treatment thereby arises above the shockwave head 2. If the carrier arm (likewise seen in the projection of Fig. 2) were aligned approximately in the direction of the shockwave axis 16, thus radially, the therapy C-arm 3 would have to be longer by approximately the arc segment 22 or, respectively, would have to be orbitally moved further by a corresponding length, whereby it would limit the freedom of movement of an attending person in the space 20.

So that both the therapy C-arm 3 and the sled 7 of the carrier arm 9 also overhang the lower arc end 19' in the arc circumference direction in the lower end position, the carrier arm 9 is borne on the sled 7 such that it can rotate around a rotation axis 23. It would now be conceivable that not only a single rotation axis is present, but

rather that the shockwave head 2 also exhibits a degree of freedom relative to the carrier arm 9. The purpose of such a movement capability would be to bring the shockwave head 2 back into a position in which its focus 13 again comes to lie on the central axis 18 (for example coincides with the isocenter 5 of the therapy C-arm 3) after cycling an orbital movement path. However, a plurality of movement possibilities or, respectively, articulation points form error sources with regard to an exact alignment of the shockwave head 2 as a result of tolerances that can never be entirely excluded given parts movably connected with one another. In the described exemplary embodiments, the shockwave head 2 is therefore rigidly connected with the carrier arm 9 likewise rigidly fashioned. The rotation of the carrier arm 9 ensues around a single axis, namely the rotation axis 23. Given a rotation of 180° around this axis, the carrier arm (like the shockwave head) is located in a mirror-inverted alignment relative to the previous position, whereby the rotation axis 23 forms the mirror axis. For x-ray-supported observation of, for instance, a lithotripsy treatment, the therapy C-arm can be provided with an x-ray C-arm coaxial with this, comprising an x-ray source (not shown) and bearing an x-ray receiver (30) without or with axial offset. In the first case, the orbital planes and the isocenters of both C-arms coincide. The rotation axis 23 of the C-arm 9 correspondingly runs in the common orbital plane of the C-arms and extends through their common isocenter. The shockwave head 2 can thereby be aligned such that its shockwave axis 16 runs in the common orbital plane. Given a rotation around the rotation axis 23 by 180°, upon transition from one end position into the other the shockwave head 2 again adopts a position in which its shockwave axis 16 runs in the orbital plane 17 of the therapy C-arm 3. The monitoring with the x-ray system can then ensue "inline" in each angle position, i.e. in the direction of the shockwave axis 16. In the second case shown in the drawings, the x-ray C-arm 24 is arranged with axial separation from the therapy C-arm 3. Its isocenter 25, like the isocenter 5 of the therapy C-arm 3, lies on the central axis 18. As is in particular to be learned from Fig. 3 and Fig. 6, the carrier arm 9 extends laterally out of the orbital plane 17. The shockwave head 2 fixed at the free end 12 of the carier [sic] arm 9 is then arranged in the region of the orbital plane 26 of the x-ray

C-arm 24, whereby its focus 13 is located in its isocenter 25. The shockwave head 2 can be aligned such that its shockwave axis 16 runs in the orbital plane 26 of the x-ray C-arm 24 in one angle position per side. However, this alignment changes given a rotation around the rotation axis 23, meaning that the shockwave axis 16 is tilted out of the orbital plane 26, whereby (as inventively intended) the common isocenter is retained.

The carrier arm 9 comprises a first longitudinal segment 27 comprising the fixed end 10 and a second longitudinal segment 28 comprising the free end 12. The longitudinal segment 27 is born on the sled 7 such that it can rotate. The rotation axis 23 (that is identical with the center longitudinal axis 29 of the longitudinal segment 27) pierces the orbital plane 17 of the therapy C-arm 3 with its one end and intersects the isocenter 25 of the x-ray C-arm 24. Given an orbital shift of the sled 7 on the therapy C-arm 3, the rotation axis 23 sweeps over the shell [sic] plane of a conical segment whose base surface is formed by the orbital plane 17 of the therapy C-arm and whose tip is formed by the isocenter 25 of the x-ray C-arm 24. The side 8 of the sled 7 from which the longitudinal section 26 projects runs at a right angle to the rotation axis 23. The second longitudinal segment 28 is fixed at an angle on the first longitudinal segment 27. Its center longitudinal axis 29 thereby forms an acute angle α (Fig. 2) with the rotation axis 23 in the projection on the orbital plane 17 and an acute angle ß (Fig. 6) in the projection on a plane spanning from the examination axis 23 and the central axis 18. When, starting from the upper table position of the Fig. 1-3, the shockwave head 2 should be moved into an under-table position (Fig. 4-6), perhaps for treatment of a left or right kidney, two symmetrical operations are necessary, namely on the one hand a rotation by up to 180° around the rotation axis 23 and an orbital shift of the sled 7. Although both movement procedures can naturally proceed simultaneously, they are described in succession for better comprehensibility. Starting from the situation in Fig. 2, if one initially begins with a rotation of 180° around the rotation axis 23 the shockwave head 2 subsequently, approximately adopts the position shown with dashed lines. As is to be learned from Fig. 2, this corresponds to a

rotation around the central axis 18. The focus 13 persists in the isocenter 25 given the rotation. The shockwave axis 16 thereby sweeps over the shell of a conical segment whose tip is the isocenter 25. Starting from the position shown in the dashed lines an orbital shift by approximately 50° (angle γ) is necessary if the shockwave head 2 should, for instance, be aligned in the +40° position and an orbital shift by, for instance, 130° angle γ') [sic] is necessary given an alignment in the -40° position. In contrast to this, an orbital movement path of the sled 7 (likewise starting from the upper table position) of approximately 240° would be required given an approximately radially-aligned carrier arm extending in the direction of the shockwave axis 16. A therapy C-arm 3 with an arc length of more than 120° would be necessary for this. In contrast to this, given an inventive embodiment of the carrier arm 9 the therapy C-arm 3 can be shorted by, for instance, a piece corresponding to the arc segment 22.